Spring 2019

Using an eye-tracking training paradigm to teach responsiveness to joint attention

Allison C. Brandmark
James Madison University

Using an Eye-Tracking Training Paradigm to Teach Responsiveness to Joint Attention

Allison Brandmark

A thesis submitted to the Graduate Faculty of

JAMES MADISON UNIVERSITY

In

Partial Fulfillment of the Requirements

for the degree of

Master of Arts

Department of Graduate Psychology

May 2019

FACULTY COMMITTEE:

Committee Co-Chairs:

Dr. Krisztina Jakobsen

Dr. Trevor Stokes

Committee Members/ Readers:

Dr. Dan Holt

Acknowledgements

I would like to express my deepest gratitude to Dr. Krisztina Jakobsen for her valuable contributions during this entire research process. Her time and dedication to this project is very much appreciated. I would also like to thank Dr. Daniel Holt, Dr. Trevor Stokes, and Dr. David Daniel for their research guidance and support. I am particularly grateful for the software development created by Edward Brandmark. Research assistance provided by Cassidy White, Sarah Skidmore, Raquel Dash, and Julia Lohman was greatly appreciated. I also wish to acknowledge the support given by Alexa Ina, my previous and current cohort members, and my supervisors. Thank you all for your contributions to my success and growth as a professional and individual.

I would also like to thank James Madison University's Undergraduate Psychology Department and the Alvin V. Baird Center for their financial support of this project.

Table of Contents

List of Figures

Abstract

Joint Attention (JA) is a social interaction in which attention is concurrently managed between an object or event and a social partner. One social partner initiates joint attention (IJA) by directing the attention of the other social partner. In return, the other social partner responds to joint attention (RJA) by following the social cues. A deficit in JA, which is commonly seen in children with Autism Spectrum Disorder, is correlated with delayed language development and lower levels of communication and social skills. Several studies have successfully trained both IJA and RJA using in-person methodologies. With the development of new technology, researchers have started using eye-tracking devices for a more precise measurement of JA. This has led to innovative training paradigms. This study used an eye-tracking device and pre-recorded videos to teach a preschool-aged child with a developmental delay to engage in RJA. While it did not generalize to IJA or in-person measures, there was a slight increase in RJA. With further refinement, this presents a potential alternative way to teach JA.

Keywords: Responsiveness to joint attention, initiation of joint attention, eye-tracking, Autism Spectrum Disorders

Introduction

Joint Attention (JA) is the ability to concurrently manage attention between an object or event and a social partner (Caruana et al., 2017; White et al., 2011). It is an ongoing social interaction with another individual (a social partner) that involves an exchange of information (White et al., 2011). JA requires triadic coordination, including making eye-contact with a social partner, looking at an object or event, and returning eye-contact to the social partner (Charman, 2003). It may consist of eye-gaze alternation, gaze following, point following, showing, and/or pointing (Charman, 2003; Leekam & Hunnisett, 1998). Eye gaze alternation occurs when the person looks between an object or event and another person, including at least triadic coordination (Vismara & Lyons, 2007). For example, when a child looks at a moving toy car, then to their parent, and back to the moving toy car, they are engaging in JA. This eye gaze from an object to a social partner is a quick non-vocal communicative exchange, possibly to draw the social partner's attention to the object. Some studies define JA as triadic coordination, but only measure eye gaze or gaze following (e.g., Charman, 2003; Whalen and Schreibman, 2003). This is especially true in the literature for in-person behavior analytic interventions teaching JA. This inconsistency in the literature is problematic. The current study will define and measure JA as triadic coordination and include eye-gaze as a secondary measurement.

The first part of JA—eye gaze—does not always occur in isolation. Another directional cue, such as a head turn, may also be included (Thorup et al., 2016). Thorup et al. (2016) tested 10-month-old infants' ability to determine the effects of a head turn on gaze following when compared to eye-movement only. In the eyes and head-turn condition, the experimenter turned their head and shifted their gaze toward the puppet. In the eyes-only condition, the experimenter did not turn their head but shifted eye gaze towards the puppet. High-risk infants—those with siblings with Autism Spectrum Disorder (ASD)—performed significantly worse in the eyes-only condition. Other studies have also demonstrated that infants look in the direction of a model's head turn (D'Entremont, Hains, & Muir, 1997) and follow head-turns better if the model's eyes are open (Brooks & Meltzoff, 2005). These studies indicate that both eye gaze and head turn are important factors in JA.

Types of Joint Attention

JA is primarily divided into responsiveness to JA (RJA) and initiation of JA (IJA). RJA is following the social cues of another person and shifting visual attention from the person to the object or event and back to the person (Billeci et al., 2016). RJA occurs when a child looks at a toy after the social partner looks to a toy and then alternates eye-gaze between the social partner and the toy. The child, in this example, is responding to the social cues of another individual.

For RJA to occur, a social partner must engage in IJA. IJA is the ability to direct another person's attention (Billeci et al., 2016). This consists primarily of eye-gaze alternation. It may also include pointing at something, showing off an object, giving an object to someone, or commenting on something (Vismara & Lyons, 2007). Pointing, showing, giving, and talking all direct attention, but they must occur in combination with eye-gaze alternation to be considered IJA. For example, a child demonstrates IJA by alternating their gaze between their parent and a toy car.

JA from a Behavior Analytic Perspective

Much of the JA research, and thus the JA terminology, comes from developmental psychology. Regardless, it can be understood within the framework of applied behavior analysis. Dube et al. (2004) suggests that the function of IJA is a mand, or command/request, for another person's behavior of attending to the desired object or event. IJA occurs when there is a motivating operation (MO) of the presence of a familiar social partner. A MO is an environmental variable that changes the value of a stimulus by increasing or decreasing the reinforcing or punishing effectiveness and is behavior altering (Cooper, Heron, & Heward, 2007). In this situation, the social partner is the MO because it increases the reinforcing effectiveness and increases the likelihood of JA behavior to occur. The antecedent is an attention-getting event, often resulting in the behavior of looking at a social partner. This results in the social partner attending to the individual, which acts as the antecedent in the next step of the behavior chain. The behavior, a gaze shift to the interesting event or object, occurs and is followed by event related and socially mediated consequences if the social partner correctly responds. These may include positive reinforcement from a social partner's participation, positive reinforcement from assistance from a social partner, another generalized social reinforcer, or negative reinforcement due to the termination of an aversive event (see Figure 1).

While IJA can be conceptualized in a behavior framework, RJA is slightly more challenging. Even though they are topographically similar, they serve different functions. RJA, like IJA, is a chained behavior consisting of following eye gaze and retuning to look at the social partner. Separating the behavior chain allows further examination of the consequences maintaining each step (see Figure 2). Dube et al. (2004) attributed the consequence of RJA to be the consequences of compliance with another's mand for attention (which reinforces the social partner's engagement in IJA). Returning to look at the social partner's face, however, is not required to receive these consequences. It is possible that for typically developing individuals, looking at a face serves as a reinforcer, and would act as the consequence for the last step. For children with ASD, who may not value social interaction and looking at faces, this can describe their decreased rates of engagement in RJA. However, it is still unclear what the maintaining contingency for the second step of RJA is. This may be why the behavior analytic literature on teaching JA focuses on teaching only eye gaze.

While much of the JA research discusses cognitive aspects and ideas, Dube et al. (2004) demonstrated that JA can be conceptualized in a behavioral framework. This paper will discuss JA in such terms.

Development of Joint Attention

RJA develops before IJA and is generally considered easier (Billeci et al., 2016). In typically developing children, RJA begins to develop between six and nine months of age and is fully developed by 12 months of age (Billeci et al., 2006; Charman, 2003). IJA begins to develop around nine months of age and is fully developed by 12 to 18 months of age (Charman, 2003). Navab et al. (2011) explained that before 12 months of age, infants may fixate on any object in the visual path, not necessarily the one they are cued to look at. By 18 months of age, infants have the skills to look at the specific target object and a typically developing child will engage in both IJA and RJA.

A delay in developing JA has a significant impact on an infant's developmental trajectory, and therefore, is important to address concerns immediately. JA is a *pivotal* *skill/behavior*, meaning that it serves as a prerequisite skill for the development of many future skills, such as language, social skills, and communication (Charman, 2003). A pivotal skill occurs when a change in one behavior leads to changes in other related behaviors without the need for any additional teaching (Koegel, Koegel, & Carter, 1999). JA is a good example of a pivotal skill because JA abilities at 20 months are reflected in the outcomes of language development and social and communication skills (e.g., eye contact, response to name, social smile, attention, appropriate gestures) at 42 months (Charman, 2003).

Similarly, JA is also a *behavioral cusp*. A behavioral cusp is when a behavior change opens the environment to have additional reinforcers, consequences, stimulus control, etc., for the individual (Rosales-Ruiz & Baer, 1997). Primarily, behavioral cusps allow access to more reinforcement. The behavior change allows the individual to encounter new contingencies, which helps augment learning (Pelios & Lund, 2001). JA allows access to reinforcers from social communication, opportunities to engage with others, and increased language development (Charman, 2003). Language and communication are both socially valid skills; therefore, JA can be considered a behavioral cusp.

Importance of Joint Attention

JA is central to the development of language and social skills, and a deficit in JA may be detrimental (Bruinsma, Koegel, & Koegel, 2004). Children with ASD, Williams Syndrome (WS), and Pervasive Developmental Disorder (PDD) display reduced JA abilities compared to their typically developing peers (Cheng & Huang, 2012; Charman, 2003).

Most of the research around deficits in JA has centered around ASD. Baron-Cohen, Allen, and Gillberg (1992) found that an early sign of ASD is the absence of JA when the infant is one year old. Further research has confirmed that children with ASD lack JA abilities (e.g., Bruinsma, Koegel, and Koegel, 2004). The JA ability of a child has been used to characterize ASD, as a prognostic indicator of ASD, and as an intervention goal for infants with ASD. For example, the Autism Diagnostic Observation Schedule (ADOS), a standardized semi-structured assessment for individuals suspected of having ASD, observes JA (which they measure as eye gaze) as a measure of diagnostic utility. Furthermore, lower rates of RJA and IJA in infants indicate an ASD diagnosis (Navab et al., 2011).

Correlational studies suggest that an infant's ability to engage in RJA and IJA can predict later language outcomes. For example, Charman (2003) measured infant's JA ability at 20 months and 42 months for infants with ASD. They determined that the severity of the social and communication deficits at 42 months could be predicted by the social and communication skills at 20 months. Additionally, IJA in infants 26-48 months with ASD was positively associated with receptive and expressive language (Toth et al., 2006). Mundy (1990) found that language at 24 months could be predicted by the 12-month RJA abilities and 18-month IJA abilities in infants. Furthermore, Loveland and Landry (1986) looked at the effects of JA and language in children with ASD and children with Developmental Language Delay (DLD). While both children with DLD and children with ASD displayed a deficit in language, children with DLD did not display a deficit in communicative skills such as responding to others and making requests, as shown with deficits in JA. They concluded that children with ASD who have a deficit in

JA have a more severe deficit in communicative skills. These studies demonstrate that the deficit of JA skills adversely affects the development of communicative skills and language development.

In addition to the development of language, JA is also correlated with increased spontaneous speech (Whalen, Schreibman, & Ingersoll, 2006), social skills (Charman, 2003), and symbolic play (Whalen, Schreibman, & Ingersoll, 2006; Kasari, Freeman, & Paparella, 2006). Whalen, Schreibman, & Ingersoll (2006) trained RJA and IJA in preschool-aged children with ASD. The results indicated that JA is a pivotal skill as there were several collateral changes identified along with the development of JA. The study supported an increase in social behaviors, including social initiations, social responding, empathic response, and positive affect. The children also displayed an increase in spontaneous speech and spontaneous imitation during play.

The deficit in JA represents a core symptom of ASD and plays a role in several other developmental disabilities. This impairment, which is a pivotal skill and a behavioral cusp, is important to overcome as it allows for future development in other areas. For these reasons, researchers have suggested that JA become a priority in treatment for children with a deficit (Mundy & Crowson, 1997; Vismara & Lyons, 2007). In fact, early intervention with behavioral treatment for children with ASD has positive long-term outcomes such as less restrictive school placements, increased adaptive behavior, and increased intellectual functioning (McEachin, Smith, & Lovass, 1993).

In-Person Training of JA

There are several behavioral interventions to increase JA. Whalen and Schreibman (2003) trained five 4-year-old children with ASD to engage in gaze following behaviors (which they referenced as RJA) and coordinating gaze shifting plus pointing (which they referenced as IJA). They used a multiple-baseline design, which is a single-subject experimental design that measures two or more behaviors in a baseline condition. In a multiple-baseline design, the intervention is applied in a sequential manner to the other behaviors or participants (Cooper, Heron, & Heward, 2007). During baseline, researchers observed and assessed IJA and RJA. The training protocol primarily used a naturalistic behavior modification technique, which combined aspects from Discrete Trail Training (DTT) and Pivotal Response Training (PRT), both known, evidence-based instructional methods (Koegel, Russo, & Rincover, 1977; Koegel et al., 1999). In DTT, the child is presented with a cue (a direction) and a prompt (assistance to respond to the cue), and their response is followed by a consequence and a short intertrial interval before another cue is presented (Smith, 2001). PRT targets the most important areas of development, including responding to multiple cues, motivation, self-management, and self-initiation (Koegel et al., 1999). PRT allows for child choice, uses natural reinforcers, reinforces attempts, and intersperses maintenance trails.

Coordinated gaze following and gaze shifting can be trained in-person using naturalistic behavior modification techniques. Whalen and Screibman (2003) used access to toys as a positive reinforcer and a series of prompting to train both gaze following and gaze shifting. In *response training*, the children were taught to respond to IJA using the naturalistic behavior modification technique as described above. The behavior was shaped through multiple levels beginning with response to hand on object and ending in following a gaze. In *initiation training*, coordinated gaze shifting was trained first. If the child did not shift their gaze to the other person within ten seconds, the toy was removed.

Physical and verbal prompts were used to establish gaze and prompts were faded until the child would shift gaze independently. Gaze following training was effective for all five participants while gaze shifting training was only effective for four of the five participants. Gaze following was the only type that generalized for all participants from experimenters to their parents. The training program was replicated and extended by Whalen, Schreibman, and Ingersoll (2006), who measured the collateral changes of training JA. They found an increase in intervals with spontaneous speech, social initiations, positive affect, and imitation after JA training.

Parents have been trained to teach JA to their child with ASD using naturalistic behavior analytic techniques (Rocha, Schreibman, and Stahmer, 2007). Rocha et al. defined RJA as gaze following; triadic coordination was not required. The procedure was very similar to the one used by Whalen and Schreibman (2003). The study showed an increase in RJA in children, as well as an increase in IJA, even though it was not directly trained. The intense training protocol and the use of highly motivating toys increased JA. This study is noteworthy because it demonstrates that it is possible to see an increase in IJA after only training RJA. Therefore, we can look for generalization from RJA to IJA after only training RJA.

The length or amount of time of an intervention is just as important as the type of treatment used. Kasari, Freeman, and Paparella (2006) provided 5 to 8 minutes of DTT focusing on a specific, individual, deficit in a skill related to JA (e.g., looking, showing, pointing) for children with ASD. They used prompting and positive reinforcement. After DTT, the child and therapist moved to the floor for a more naturalistic environment. They concluded that skills related to JA, JA (point following), and play skills can be taught and improved using DTT, and the skills can generalize across caregivers.

Another evidence-based ABA teaching strategy is least-to-most and most-to-least prompting. Least-to-most prompting includes providing the smallest, least invasive prompt first, and providing larger, bigger prompts only if the smaller prompts are not enough to emit the behavior (Cooper, Heron, and Heward, 2007). Most-to-least prompting requires the gradual fading of the original prompt (Cooper, Heron, and Heward, 2007). It is the opposite of least-to-most prompting because the largest, most invasive prompt is provided first and then removed slowly until no prompt is required for the behavior to occur. Both most-to-least and least-to-most prompting are systematic and effective ways to train JA. Taylor and Hoch (2008) trained young children with ASD to respond to JA bids and to initiate bids for JA. For both RJA and IJA, they required triadic coordination. For training on RJA, researchers used least-to-most prompting to prompt the participant to follow the point, to comment on the object, and to look back at the instructor. For training on initiating bids, most-to-least physical, gestural, and vocal/echoic prompts were used. Post-training probes showed an increase in RJA and IJA, but the results did not generalize beyond the treatment environment.

Several studies have demonstrated that children are more likely to engage in JA or to gaze follow if they are interested in what is happening in the environment. Taylor and Hoch (2008) and Baker (2000) used socially relevant and motivating stimuli to increase JA. Baker used a BINGO game played with siblings to demonstrate that when there is a highly reinforcing activity, children with ASD are likely to engage in social play, which leads to an increased amount of JA. Similarly, Naoi et al. (2008) demonstrated an increase in IJA with the introduction of a treatment that used preferred items as the objects of the JA and used attention and praise as reinforcement. The deficit of JA in children with ASD may be due to the lack of motivation, rather than due to a skill deficit (Vismara & Lyons, 2007). For two of the three children, the intervention using the child's perseverative interests displayed a higher rate of JA initiations. These highly reinforcing interests structured the environment so that the child engaged more in the desired behavior.

Positive consequences provided to the child after a behavior is essential to reinforce, or increase the likelihood, of the behavior. Positive reinforcement is highly effective when used in training settings (Vollmer & Iwata, 1991); therefore, regardless of the additional effects it may provide, it should always be used when training JA. White et al. (2011) conducted a systematic review of the literature on teaching joint attention. While several behavioral strategies were used across the different studies, reinforcement was used in almost all the successful interventions. White et al. discussed the importance of strong reinforcers that match the natural contingencies. When natural social partners and natural reinforcement contingencies were used, generalization was more likely to occur.

Many of the training studies used Discrete Trial Training and Naturalistic Teaching to train JA. These interventions are effective in increasing JA, however, coupled with motivating stimuli and reinforcing consequences, they are more powerful.

Eye-Tracking Research

The previous studies used human observers to track where the participant was looking. While this allows researchers to determine if the participant is engaging in joint attention, the data may be biased, inaccurate, or less precisely measured than desired. Automatic eye-tracking, which can be achieved with an eye-tracking device, may eliminate several of these problems. While it will never replace human-coding, it allows researchers to ask different questions about things such as fixation length, duration of eye-gaze, latency of eye-gaze, and pinpointing where the participant is looking. It quantifies the data and creates a permanent product, a concrete outcome that is durable over time (Oakes, 2012; Navab et al., 2012).

Eye-tracking research informs researchers about the patterns, fixations, and gazes of eye-movements (Henderson & Hollingworth, 1998). It is an unobtrusive way to measure someone's visual behavior and observe how they gather visual information about the environment. Research supports using eye-tracking devices to measure eye-movements and eye-gaze in children with ASD (Falck-Ytter, Bolte, Gredeback, 2013; Constantino et al., 2017).

Using Videos to Measure Joint Attention

Previous studies using pre-recorded videos have successfully measured JA. In these videos, a model typically is against a black background wearing a neutral colored-shirt with their hair tied back. Identical objects are placed in corners of the screen and the model's gaze begins looking down. Depending on the study, the model uses a social greeting phase before turning his or her head and looking at an object. The model keeps a neutral facial expression and remains silent when looking at the object (Billeci et al, 2016; Navab et al., 2012). Billeci et al. (2016) also used a pre-recorded video to measure RJA and IJA and demonstrated that an eye-tracking device not only measures JA but can give new insights (such as where on the face the participant looks).

While there are major differences between an in-person measure and a prerecorded video measure of RJA, construct validity for an eye-tracking measure has been established. Navab et al. (2012) discusses that while a live person may be more engaging, using a pre-recorded video allows for more consistency. They used a prerecorded video on the eye tracking device and compared the rates of RJA from the video to the rates of RJA from an in-person measure. They established construct validity for 18-month-old infants of eye-tracking measures of RJA. Additionally, there was no difference in toddler's learning from in-person and video conditions where ostensive gaze and language cues were used (Lauricella, Barr, & Calvert, 2016).

This can be taken a step further; JA can also be measured during live videos. McClure et al. (2018) researched joint visual attention (JVA) using a live video chat at home. JVA includes directing or following a social partner's gaze to look at the same object or event. It is similar to JA, but does not require the triadic coordination. In this situation, JVA occurs across settings: the environment the person is in and the environment of the person on the screen. Nevertheless, JVA still occurs. They found that younger children (6-16 months) did not engage in initiating JVA, but the older children (16-24 months) did. Therefore, it is important to ensure that participants whose initiating JVA abilities are being studied by a computer screen and video are older than 16 months. McClure et al. also found differences in JVA abilities by how much the mother of the infant engaged in JVA and the sensitivity of the person on the other end of the video.

With videos, transferring learning across contexts is required. Moser et al. (2015) addressed learning from touchscreens and television. They looked at transfer learning: information that must be transferred from one context (a 2D screen) to another context (real world, 3D environment). A bidirectional transfer deficit is a deficit in transferring learning across dimensions. Across all measures (gesture imitation, action fidelity, goal imitation, and goal efficiency), 3-year-old participants outperformed 2-year-old participants in bidirectional transfer learning. However, a transfer deficit was present at both ages. Because younger children cannot transfer learning across contexts, it is unlikely that they will be able to transfer what they learned from the videos on the eye-tracking device to actual people. Therefore, extreme caution should be used when planning for generalization from videos to real life for children under 3-years old.

Training with an Eye-Tracking Device

While the eye-tracking device is used for research, a few studies have used it as the mechanism for training. Johnson, Amso, and Slemmer (2003) attempted to teach 4-month-old and 6-month-old infants object-trajectories by tracking their preemptive eye movements with an eye-tracking device. The training modified the stimuli presentation and prompted the desired eye-movements. Four-month-old infants' anticipatory eye movements of the object trajectories increased after training. This study demonstrates that infants can be taught to engage in certain eye-movement specific behavior from the eye tracking device.

Training for gaze-contingent paradigms with an eye-tracking device has been demonstrated to be effective in cognitive control, sustained attention, reduced saccadic reaction time, and a lower latency to disengage visual attention (Wass, Porayska-Pomsta, Johnson, 2011). Wass et al. (2011) trained 11-month-old infants in attentional control tasks. The training stimuli varied depending on responding, but typically, when the infants looked at the target object, they received an animation as a reward. The difficulty levels increased as the infants progressed through training. Cognitive control was measured by the participant's ability to inhibit a known rule and acquire a new rule. Sustained attention was measured by the duration of looking behavior.

Another study looking at gaze-contingent eye-tracking paradigms taught adults to look to specific locations on a video clip where typically developing children looked (Wang et al., 2015). A heat map of where the children looked was stacked on the original video, so that the areas that were looked at less often were darker and blurrier than the areas with more concentrated visual attention. The heatmaps were able to redirect adults' attention. This study by Wang et al. (2015) demonstrated that changing the appearance of a video to redirect attention is effective for training adults.

Purpose of Study

Although JA develops early in life, Oberwelland et al. (2016) found that the neural substrates of JA continue to develop and are subject to change throughout childhood and even adolescence. The present study attempted to train RJA in preschool children with a deficit in JA using pre-recorded videos displayed on an eye tracking device. We hypothesized that after the training, children will (1) engage in RJA on the eye tracking device, (2) be able to transfer their learning to an in-person measure, and (3) demonstrate an increase in IJA in the in-person measure after training.

Methods

Participants

The participant, Alexa (pseudonym) was a pre-school girl who was four-and-a-half years of age, demonstrated a deficit in joint attention, and was diagnosed with a developmental delay. She displayed characteristics of ASD but not to a clinical diagnostic level. Her deficit in JA ability was determined by a parent interview and an in-person observation. Additionally, according to parent report, she spent 0-.5 hours a day on video chat and 2-4 hours a day watching television. She had started preschool a month prior to the start of her participation. She participated in the RJA training.

Children were excluded if parents reported any uncorrected vision concerns or medical conditions that would impede participation. Children were also excluded from the RJA training study if they appeared to be able to engage in JA from the parent interview or if they independently engaged in RJA above the criterion levels in-person or during baseline sessions. However, some children who engaged in JA were used as control participants. Control participants—typically developing individuals who engaged in joint attention consistently—were also included in the study as a comparison group. Five control participants were between the ages of 4 and 5, and two control participants were older than 18.

Of the control participants, Carl (pseudonym), a 5.5 year-old-boy, was used for opposite RJA training. Carl had attended preschool for three years prior to the study. He spent 0-.5 hours a day on video chat, and 0-.5 hours a day watching television.

The study was approved by James Madison University's Institutional Review Board (IRB) and the parent/guardian provided written informed consent.

Setting

The study was conducted in Miller Hall and the Campbell Building at James Madison University. The lab room in Miller Hall, which is approximately 4.5m by 4.5m, contained the eye-tracking device. The room was set up so that there was a curtain separating the computer monitor with the eye-tracking device and a second monitor that controlled the eye-tracking device. There was a second nearby room in Miller Hall that was used as a play and break area. It contained a couch, space on the floor to play, and several toys. Additionally, a clinic space in the Campbell building was used for the in-person session. This room was 4m by 3m and contained a couch, a child size table, child size chairs, and some toys.

Materials

A questionnaire was given to parents over the phone prior to the first session. The questionnaire included JA related questions from the Quantitative Checklist for Autism in Toddlers (Allison et al., 2008). Additionally, questions asked if the parents have observed each of the behaviors described and detailed in the Abridged Version of the Early Social Communication Scale—Adapted (Benson & Joosten, 2014). This consisted of following a point, response to eye contact, eye contact, pointing, and showing. The questionnaire also asked about the number of hours per day the child spends on video chat (e.g., facetime, skype) and the number of hours per day the child watches television. Researchers also asked questions about family history, such as if the child has an older sibling with ASD or another disability, and medical questions, such as if the child has vision concerns. Finally, a generic preference assessment was given to the primary caregiver to determine what the child potentially finds reinforcing. See Appendix for questions.

A Tobii TX300 eye tracking device measuring corneal reflection was used. The Tobii device, integrated with a 27-inch monitor, uses cameras under the monitor and infrared light to measure the distance between the cornea and the pupil of both eyes.

Design of Study

RJA Training. This study was a single case ABCDD' design. Condition A was baseline, B was Training 1, C was Attention Training, D was Training 2, and D' was Training 2—shortened. In a single case design, the individual participant serves as their own control (Lobo et al. 2017). The systematic changing of conditions, or independent variables, allows for experimental evaluation. The different independent variables are then compared to the baseline measurement. This controls for some confounding variables, including individual characteristics and past experiences, because the participant is compared to themselves.

Opposite RJA Training. This study was a single case AB design. Condition A was baseline and condition B was Training 1. This training replicated the RJA training, except the goal was to teach a child with RJA abilities to look in the opposite direction of the model's eye gaze. This was used to demonstrate the effectiveness of the training.

Control. This was a case study because there was no experimental manipulation. Here, the baseline measures of all 8 participants were compared.

Stimulus

The cue videos used in baseline consisted of a series of videos of one female model looking at an object using eye-gaze and making a slight head turn toward the object. The object, which was a neutral unfamiliar character, was in the four corners of the screen. The object was white on a black background, and the model was wearing a neutral color shirt. The model looked straight at the camera for 10 seconds, then to one of four objects for 10 seconds, and returned their gaze to the camera for 10 seconds (see Figure 3). The cue videos contained no within stimulus prompting. In Training 1 the same videos of the model looking at any one of the four objects was edited to provide within stimulus prompts for RJA. The cue videos looking upper right (cue 1), upper left (cue 2), lower right (cue 3), and lower left (cue 4), remained unedited.

In attention training, preferred videos from TV shows and movies were shown. Additionally, videos from Training 2 were also shown.

The training protocol used in Training 2 and Training 2—shortened consisted of less controlled but more visually appealing videos than Training 1 (see Figure 4). There were several different models used in the series of videos. The models looked at the camera, said “hello,” looked to one of the four objects, and returned their gaze back to the camera. The videos lasted about 10 seconds. The objects, located in the four corners of the screen, were colorful cartoon pictures from Alexa’s preferred TV shows and movies. For example, the objects included Daniel Tiger’s Trolley, Willy Wonka’s factory, and Pinkalicious’ castle. The videos were edited to provide within stimulus prompts for RJA (see Figure 5). The cue videos looking upper right (cue 1), upper left (cue 2), lower right (cue 3), and lower left (cue 4), remained unedited. Only the engagement in RJA with the cue videos was scored. When Alexa successfully engaged in RJA with any of the videos, a related colorful cartoon object appeared in front of the correct object and moved around in that corner of the screen. For example, the objects that appeared included Daniel Tiger, Willy Wonka, and Pinkalicious (see the fourth picture in Figure 4).

The edited videos consisted of different levels of visibility of the background. The background transparency ranged from 0% (completely visible) to 100% (completely black). The foreground consisted of just the model’s face and the one object the model looked towards. Additionally, extra stimuli were added to the main focal points to draw in the child's attention by using a flashing starburst effect (see Figure 3 and Figure 4 for static images of the videos).

Using most-to-least prompting, the first video displayed in the Training 1 protocol, *prompt A: face only with flash*, only showed the model's face region and the target object. The face and object were accentuated by video effects that make the areas flash in an alternating pattern by having a yellow 8-point star appear and disappear multiple times behind the object. The star flashed by the face, then by the object, then back to the face. Nothing but the face and the object were visible. True to a most-to-least training protocol, *prompt A: face only with flash*, was designed so that the participant was successful.

The second training video, *prompt B: face only*, consisted of just the woman's face and the object, where neither was flashing. The third training video, *prompt C: fade 60% with flash*, consisted of the video with the background faded and the starburst behind the face and the object flashing in an alternating pattern. The fourth video, *prompt D: fade 60%*, had the background faded at the same level as *prompt C: fade 60% with flash*, but without the flashing. The fifth (*prompt E: fade 30% with flash*) and sixth video (*prompt F: fade 30%*) were exactly like the prompt C and prompt D videos, respectively, except the background was slightly more visible. The seventh video (*prompt G: flash only*) was the original cue video, except the starburst behind the face and the object blinked in an alternating pattern.

The Training 2 and Training 2—shortened conditions only consisted of prompt A, prompt C, prompt E, and prompt G videos. All these videos contained the flashing effect.

The other videos were removed, which allowed the participant to move faster through the training. See Figure 2 for an example.

The participant moved through the training videos according to a decision tree (see Figure 3). The structure of the decision tree was the same for Training 1, Training 2, and Training 2—shortened, except that in both Training 2s, only prompt videos A, C, E, and G were shown. If the participant successfully engaged in RJA within ten seconds of the model looking to the object, they received positive consequences and then moved onto the next video. Positive consequences included receiving an edible and social praise. In the Training 2 conditions, the fun object appeared on the screen. Additionally, the participant intermittently received preferred video clips. If they failed to engage in RJA, they returned to the previous training video and received no positive consequence.

After seeing all the prompt videos, the participant was shown a cue video. If they got a cue video correct, they were presented with another cue video. This repeated until they reached mastery criteria of three out of four videos. If they got a cue video wrong, they were shown one redemption cue video. After two incorrect cue videos in a row, the participant began the prompt sequence again, starting with prompt A.

In the opposite RJA training, the stimulus videos from Training 1 were used, but the within stimulus prompts were edited because the participant was reinforced for looking in the opposite direction of the model's eye gaze. For example, if the model looked to the upper right, the object in the lower left corner was correct. The within stimulus prompts flashed behind the object in the opposite direction of the model's gaze. This was conducted to test the effectiveness of the training paradigm with a typically developing peer. Because Carl, the participant, engaged in JA naturally, he was taught to look in the opposite direction.

For the control, the cue videos from Training 1, as previously described, were used. No videos within stimulus prompting were shown.

Measures

Measurement of In-Person JA. Responding to Joint Attention (RJA) was scored when Alexa directed her attention to the location cued by eye-gaze and a slight head turn of the social partner. She had to fixate for at least one second on the item/event and then return her attention to the social partner within 10 seconds of the social partner's cue for RJA to be scored. Prior to the social partner initiating JA, Alexa's attention was received. No RJA was scored if she never attended to the social partner. Attention was measured as looking; Alexa's eyes had to look at the location cued.

Initiation of Joint Attention (IJA) was scored if Alexa made a referential 3-point shift in gaze between an object or event and a person with at least a one second fixation at each point within 10 seconds. This required an observation of an event or object and establishing shared attention with a social partner. Pointing, without an eye gaze alternation, was not scored.

Measurement of In-Person Eye Gaze. Eye gaze was scored when Alexa directed her attention to the location cued by the social partner and fixated her attention on the object for at least one second. She did not have to return her eye-gaze to the social partner. For eye gaze to be scored, Alexa had to pay attention to the social partner.

Measurement of Eye-Tracking JA. On the eye-tracking device, RJA was measured, but IJA was not. An opportunity to engage in RJA was only presented after the participant was attending to the screen. RJA was when the participant directed their attention from the model's face to the location cued by the model and fixated within a 30-pixel radius of the item for at least 100ms on the eye-tracking device and then returned their attention back to the model. This had to have occurred within 10 seconds of the model's eye movement/head turn towards the object. The observers estimated the radius and length of time live to determine what prompt to show next. The observers also used a video of the participant to determine where they looked if the eye-tracking device was unable to measure where they were looking.

Measurement of Eye-Tracking Eye Gaze. Eye gaze was scored after the participant attended to the screen and directed their attention from the model's face to the location cued by the model and fixated within a 30-pixel radius of the item for at least 100ms. They did not have to return their attention back to the model. This had to have occurred within 10 seconds of the model's eye movement/head turn towards the object.

Measurement of Opposite RJA. This is the same as measurement of eye-tracking JA, expect that it measured when Carl looked to the opposite direction of the model's eye gaze.

Measurement of Attending. Time attending to the videos on the eye-tracking device was also noted from the recorded videos (i.e., this was not scored live). Time attending consisted of anytime Alexa was oriented to and looking at the computer screen while she was within two feet of the table the eye-tracking device was on. Looking at the computer screen was retroactively scored using the measurement from the eye-tracking device and the video of the session. There were times where Alexa was attending but the eye-tracking device did not pick up on her eyes. Total time consisted of anytime any video was shown to Alexa. This was not necessarily the session length because it did not include breaks away from the computer.

Procedure for RJA Training

Screening. The primary caregiver completed a questionnaire over the phone prior to participating in the study. If the child appeared to have a JA deficit according to the questionnaires, they were brought into the lab for a pre-baseline measure.

Pre-Baseline. Upon arrival, the child engaged in play with the experimenter (a novel person) while the primary caregiver was in the room in sight. The experimenter used Child Directed Interaction (CDI) which instructs the therapist to follow the child's lead in play to enhance the relationship (Eyberg, 1988). This time allowed for rapport building and for the child to get used to the space. This lasted approximately five minutes. During this time, the primary caregiver was trained in how to engage in IJA specifically for this study.

A similar procedure to Whalen and Schreibman (2003) was used. The primary caregiver was directed to engage in IJA with the child once every other minute for 10 minutes. They were prompted through a "bug-in-the-ear" system which consisted of the primary caregiver wearing an FM receiver that fits into their ear like a hearing aid. The research assistant who prompted the primary caregiver had an FM transmitter with a microphone. The experimenter engaged in IJA with the child once every other minute, alternating minutes with the primary caregiver. This provided Alexa with a bid for RJA once every minute, alternating between the primary caregiver and the experimenter for a total of 10 minutes. The primary caregiver or the experimenter got Alexa's attention before engaging in IJA. If they were unable to gain Alexa's attention after three attempts, they continued with play and it was scored as “not attending.” Observers were in a separate room divided by a one-way window, so they could see Alexa, but she could not see them. They only scored RJA if Alexa was oriented towards the social partner prior to the bid. A secondary observer scored any occurrences of IJA that occurred during the 10 minutes. The final few minutes consisted of a preference assessment based on the results from the screening. The whole session took less than 30 minutes (see Figure 4 for the complete pre-baseline schedule).

Baseline. Upon arrival to the lab, the participant played in the adjacent play room for a few minutes while their caregiver filled out the demographic survey. The participant then came to the lab room and sat at the computer. During some sessions, the participant sat at the computer in the caregiver’s or experimenter’s lap. The participant first saw a dancing animal with sound move around the screen to nine points for the eye-tracking device to calibrate. They then saw four cue videos of the model, who was pre-recorded, initiate JA to different locations. The order of the cue videos was randomized, but no two videos looking in the same location were showed in a row. RJA was measured for each cue video. The participant received non-contingent reinforcement at the end of each cue video.

Intervention. Similar to baseline, Alexa either played with the experimenter for a few minutes upon arrival or went straight to watching the videos. To calibrate the device, she saw a dancing animal with sound move around the screen to nine points. Alexa then saw two cue videos of a model initiating JA to a location. The first two videos were not scored. Alexa was praised for watching the videos. The third cue video began the decision tree (see Figure 3) and the most-to-least prompting sequence.

Training 1. After watching the cue video, if Alexa failed to engage in RJA, the training protocol began where she watched prompt A through prompt G one time each. The location where the model looked in the training video was randomized in the prompt videos, but no two videos looking at the same direction were shown in a row. When Alexa successfully engaged in RJA from a prompt video, an observer behind the curtain played a tone, indicating to the experimenter to deliver a positive consequence. Positive consequences consisted of an edible and social praise. Intermittently, a preferred video was shown. To get Alexa's attention back to the screen after the positive consequence, an 'attention-getter' consisting of a moving image of an item or cartoon character and a sound was played. The attention getter was varied throughout the session. After Alexa established eye-contact with the screen, the next prompt video was played. If she did not engage in RJA within 10 seconds of the prompt video, she was shown the previous prompt video. This was repeated until successful completion of all the training videos. Alexa received play and bathroom breaks, as appropriate. Alexa repeated the training procedure until she asked to be finished, had difficulty attending, or until she had participated for 45 minutes.

Attention Training. The attention training condition consisted of bringing Alexa's attention to the videos under stimulus control. She was reinforced initially for watching 10 consecutive seconds of a preferred video, then 20 seconds, and then 30 seconds. Then, she was reinforced for watching 3 consecutive seconds of a JA video, then 6 seconds, and then 9 seconds. Once she successfully watched 9 consecutive seconds of a JA video for 5 videos, she was moved to the next condition. During the attention training condition, her engagement in JA was not required for reinforcement, nor was it measured.

Training 2. Training 2 and Training—2 shortened videos followed the same procedure as Training 1, except the videos were different and she only watched prompt A, C, E, and G. In Training 2—shortened, the sessions were concluded at 15 minutes. Around 10-12 minutes in this condition, cue videos were played again regardless of where Alexa was in the sequence so that the effects of the training could be measured.

Alexa returned weekly or bi-weekly to repeat the procedure until she reached mastery criteria. Mastery criteria was when she engaged in RJA for three out of four consecutive cue videos on two separate sessions. However, the study was concluded after 20 intervention sessions (not including the in-person sessions).

Post-test. Alexa returned after she attended 20 intervention sessions for an in-person measure of JA. This follow-up session ran exactly as the initial baseline session, except that no preference assessment was conducted in the last five minutes. Instead, the last five minutes consisted of a novel therapist engaging in IJA every minute. Mom was in the room with Alexa and the novel therapist, but the experimenter was not in the room.

Procedure for Opposite RJA Training

This procedure was like the procedure for RJA training, but it only consisted of the screening, baseline, and intervention—Training 1 conditions. The only difference in the intervention was that Carl was reinforced for looking in the opposite direction of the model's eye gaze and not for engaging in RJA. Carl returned weekly for four weeks.

Procedure for Control

This consisted of just one baseline session where multiple cue videos were shown.

Data Analysis

Measurement of In-Person JA

When measuring the amount of RJA Alexa engaged in with an in-person social partner, percent per opportunity was recorded. There were JA bids every minute, either by the primary caregiver or the experimenter. Observers recorded whether the child engaged in RJA after a JA bid. They recorded either a “yes,” “no,” “not attending,” or “not observed.” To measure the amount of IJA the participant engaged in, observers recorded the frequency.

Interobserver Agreement (IOA). A research assistant scored all in-person sessions live (the baseline sessions and the posttest). A second research assistant also scored all the sessions live. When both research assistants scored the in-person measures, they took data simultaneously but made all scoring decisions independently at that time. Total count was used to calculate IOA. The smaller count was divided by the larger count, and this number was multiplied by 100.

Measurement of Eye-tracking JA

To measure the amount of RJA Alexa or a control participant engaged in on the eye-tracking device, an average percentage was taken from all the cue videos they were shown. This did not include the first two cue videos during training sessions. The number of cue videos the participants engaged in JA with was divided by the total number of cue videos they were shown. This was multiplied by 100 to get a percentage.

IOA. A research assistant scored the sessions live, and a second research assistant scored the session from a video recording. Total count was used to calculate IOA. The smaller count was divided by the larger count, and this number was multiplied by 100. No IOA was calculated for control participants.

Measurement of Eye-tracking Eye Gaze

To measure the amount of eye gaze Alexa engaged in on the eye-tracking device, an average percentage was taken from all the cue videos she was shown. This did not include the first two cue videos during training sessions. The number of cue videos she engaged in eye gaze with was divided by the total number of cue videos she was shown. This was multiplied by 100 to get a percentage.

IOA. A research assistant scored the sessions live or from a video recording, and a second research assistant scored the session from a video recording. The research assistants scored the videos separately. Total count was used to calculate IOA. The smaller count was divided by the larger count, and this number was multiplied by 100.

Measurement of Attending

The percentage of time attending was calculated by dividing the time attended by the total time.

IOA. No IOA was measured for time attending

Measurement of Opposite RJA

To measure the amount of opposite RJA Carl engaged in on the eye-tracking device, an average percentage was taken from all the cue videos he was shown. This did not include the first two cue videos during training sessions. The number of cue videos he engaged in opposite RJA with was divided by the total number of cue videos he was shown. This was multiplied by 100 to get a percentage.

IOA. No IOA was calculated.

Data Analyses

Visual analysis was used to analyze the results. A systematic approach to visual analysis was used, such that the level, trend, and variability of the data was analyzed systematically. Consequently, these three key features were compared within and across conditions. Additionally, the number of data points and any patterns, cycles, or sequences between and within phases were visually analyzed. Parsonson (2003) suggested looking for those characteristics to systematically analyze a graph to effectively display and understand the results. Beyond its traditional role in behavior analysis, visual analysis allows a quick, unmodified, and accurate understanding of behavior (Parsonson, 2003).

Results

In Person Sessions

Figure 5 displays the percentage that Alexa engaged in RJA with her caregiver, the experimenter, and a novel person in the in-person sessions both pre- and post-training. The novel person was only tested in the post-training condition because the experimenter was novel to Alexa in the pre-training measure. In the pre-training measure, Alexa engaged in more RJA with the caregiver than she did with the experimenter. However, in the post-training measure, Alexa engaged in slightly more RJA with the experimenter than with the caregiver. There was also a significant increase in Alexa's engagement in RJA with the experimenter from the pre-training to the post-training measure. There was no change in engagement in RJA with the caregiver between the pre-training and the post-training measures. Additionally, Alexa did not engage in RJA with the novel person in post-training, which matches her engagement in RJA with the experimenter when they were novel in pre-training. For all three people, Alexa's percent of eye gaze was higher than her percentage of RJA. There is a decrease in eye-gaze from pre-training to post-training with her caregiver. IOA collected for the in-person measures ranged from 80-100%, with an average of 95%.

In addition to measuring RJA during the in-person measures, the frequency of IJA was recorded in a ten-minute sample. The amount Alexa engaged in IJA decreased from the pre-training session to the post-training session (Figure 6).

RJA Training

Figure 7 graphically displays Alexa's percentage of RJA with the pre-recorded cue videos on the eye tracking device, percentage of eye gaze with the cue videos, and percent attending to all the videos. The percent of RJA in baseline, Training 1, and Training 2 were all at similar levels, around 0%. In Training 2—shortened, there was a level change from a low level to a mid-low level in both RJA (0% to 10-33%) and eye gaze (0% to 20-50%). There is a slight increasing trend for the percentage of RJA. Eye gaze shows more stable responding in Training 2—shortened than in Training 2. While there was an increasing trend from sessions 14-17, eye gaze ended on a decreasing trend. Additionally, from the three probes we took of her RJA with characters in preferred videos (cartoon characters and movie characters), she engaged in RJA for 100% of the videos.

Figure 7 also displays the percentage that Alexa attended to the videos. In baseline and Training 2—shortened, the percent attending correlates with the percentage of RJA. In baseline, attention had a decreasing trend. After the attention training, the percent attending was above 80%. However, it had a decreasing trend in both Training 2 conditions.

Session 2, 4, 5, 11, 13, 15, and 17 were conducted on the same day as the session prior to it, with sessions 3, 4, and 5 all occurring on the same day. There is no difference between these sessions and the first sessions in RJA, eye gaze, or attention. On session 6, the participant did not attend to any cue videos, so no data could be collected. There was a recording error on session 7, so no data was able to be collected. A two-week break occurred between sessions 8 and 9, and a three-week break occurred between sessions 11 and 12. Session 18 and 19 occurred on the same week. All other sessions occurred a week apart.

IOA for RJA was collected for 82% of the sessions. The IOA ranged from 50-100%, with an average of 89%. IOA for eye gaze was collected for 64% of the sessions. The IOA ranged from 33-100%, with an average of 80%.

As Alexa received more training, the frequency of which prompt videos she watched most changed (Figure 8). Following the decision tree, the more times Alexa correctly engaged in RJA with a prompt-level video, the fewer videos from that prompt-level she was shown. The more times she got it wrong, the more times she was shown the prompt-level video one prompt up (a higher-level prompt). Between sessions 12 and 16, the number of prompt A videos (the most prompting received) had a decreasing trend, while the number of prompt C videos had an increasing trend. Sessions 12 through 16 also saw an increasing trend in engagement in RJA (see Figure 7). However, there was no clear trend in the number of each prompt videos she watched across all sessions and no correlation to RJA.

Control Comparison

Figure 9 displays the baseline levels of RJA and eye gaze in typically developing children and adults. Typically developing participants who were older than 5 years of age engaged in JA and eye gaze for 100% of the cue videos in baseline. Typically developing participants who were 4 or 4.5 years old engaged in RJA and eye gaze for at least 50% of the cue videos. Comparatively, Alexa engaged in lower rates during baseline. Her first baseline session was recorded. She engaged in RJA and eye gaze for only 25% of the cue videos. Besides her first baseline session, however, she only engaged in RJA for 0% of the cue videos.

Opposite RJA Training

Carl did not engage in opposite RJA during baseline (Figure 10). In the intervention, Carl engaged in 22-25% of opposite RJA. The data were very stable in intervention and was at a mid-low level. There was an increase in level from baseline.

Figure 11 shows the percentage of prompt videos that Carl watched during opposite training. There is a decreasing trend in the number of prompt A and B videos that he watched. There was also a slight increasing trend in the number of prompt C, D, E, and F videos that he watched.

Discussion

Alexa displayed a minor increase in RJA behaviors on the eye tracking device. Comparing her to typically developing peers from the study, we would expect her to engage in RJA for at least 50% of the videos consistently at age 4.5 if the training was successful. Because she did not engage in RJA with the videos above 30%, we can conclude that the current training had little effect on her RJA abilities. She never met criteria for mastery. With no consistency in RJA engagement on the eye tracking device, no change in-person was expected.

However, Alexa's RJA in the in-person session increased with the experimenter from pre- to post-training. This can be attributed to familiarity because children are more likely to engage in JA with familiar adults (Dube et al., 2004). Alexa and the experimenter developed a relationship across the length of the experiment. The experimenter was paired with reinforcement in the training sessions, making Alexa's learning history different in the post-training observation than the pre-training observation. Additionally, familiarity with the environment and expectations might have played a role, especially in the decrease in IJA from the pre- to post-training. Alexa may have initiated more JA in the pre-training session because she was in a new environment. According to social referencing theories of JA (Kasari, Sigman, Mundy & Yirmiy, 1990), Alexa may have been looking to mom to see how she was reacting to the new environment. While typical of a natural environment, having toys in the room may have created competition for Alexa's attention. This may have influenced her rates of IJA and RJA.

While there was not a large enough increase in RJA on the eye-tracking device where a change in-person was expected, the plans for generalization were lost when the new videos were created. Possible ways to include generalization consist of having the experimenter in the videos, recording the videos in a natural environment, and conducting some in-person training. There might have been an increase in RJA or IJA if generalization was planned for. Future research should plan and prepare for generalization since children struggle to generalize from 2D to 3D contexts (Moser et al., 2015), and children with ASD struggle with generalization overall (Stokes & Baer, 1977).

During baseline, Alexa watched the first few cue videos before she would say that she was all done or ask for a break. Her caregiver would prompt her to watch a few more videos and she complied. While her attending in Training 1 was higher than in baseline, she had difficulty attending to the cue videos in Training 1. This may have occurred because the cue videos were no longer novel and/or because they were presented at the end of a long sequence of prompt videos. She often was prompted to watch the cue videos before she could access a break, possibly pushing her to attend past her limit. She would occasionally attend to the first and last part of the video but miss when the model shifted her eye-gaze, making it impossible for her to correctly engage in RJA. Interestingly, during the prompt videos she began looking from the computer screen, to the experimenter, and back to the computer screen during the intervention videos. She was initiating JA with the experimenter, despite not engaging in RJA with the videos. However, this took her attention away from the videos. Additionally, her frequency of IJA during the in-person post-training session did not indicate that she was able to consistently engage in IJA.

After Alexa's low rates of attention in Training 1 sessions, an attention training procedure was implemented. Since the videos provided the prompts, it was crucial that Alexa watched them in their entirety. While implementing the attention training procedure, Alexa engaged in a lot of verbal refusals. She even began putting her head on the table after seeing the RJA videos pop up. To counteract this, new videos were created and shown to her. While these videos had less experimental control, they were more engaging. The first time these videos were introduced was in session 8, which correlates with her high percentage of attending during that session. This can also be attributed to the fact that there were no demands to engage in RJA. With holidays and scheduling issues, there was a two week break between the attention training and Training 2 condition (sessions 8 and 9). This may explain the drop in the percent of attending. However, week 9 saw the highest rates of RJA and eye gaze.

The introduction of the new videos with more exciting objects and a cause-and-effect feature may have influenced high rates of attending in session 8. However, in sessions 11 and 12 she was still attending for less than 60% of the session. In sessions 12 and 13, Alexa consistently began asking to go play after 10-15 minutes of watching videos. Since there were four sessions of 0% RJA, Training 2—shortened was introduced. Whereas we previously waited for Alexa to go through the prompt videos to see cue videos, we showed a cue video regardless of where she was in the prompt sequence after 10-12 minutes. This kept the sessions briefer, and RJA and eye gaze increased (see Figure 7). Had the intervention began with Training 2—shortened, there may have been a bigger change across the sessions and mastery by session 20. However, the data from the first fifteen minutes of previous sessions was consistent to the data from the entire session. Anecdotally, Alexa became more disinterested in the videos the more she saw them. Videos, objects, and characters should have been varied each session in attempt to keep Alexa's interest.

A major limitation of this study was Alexa's attention to the videos. She attended to the videos for less than 50% of the time for over half of the sessions. She would watch the preferred videos consistently, demonstrating that she had the attending skill but that it was not under stimulus control of the JA videos. Had Alexa attended at a higher rate consistently, the training may have been more effective. This study should be replicated with an older participant who has the ability to attend for at least 10 minutes.

The Training 2 conditions also included showing Alexa preferred videos intermittently. Alexa had difficulty transitioning from the preferred videos to the RJA videos. She occasionally fixated on something from the preferred video or kept asking to see it. Alexa would engage in RJA with the characters in the preferred videos. This was observed with both cartoon people (schematic) and real actors (actual). Research supports that human faces and cartoon faces are processed differently (Rosset et al., 2010), possibly because the social relevance is different. Children who are typically developing and children with ASD do process real and cartoon faces differently from each other, whereas there is no difference in the discrimination of cartoon and real faces in children with ASD (Rosset et al., 2010). Grelotti et al. (2005) found that children with ASD individuated faces from their highly preferred characters faster than regular faces. While Alexa did not have an ASD diagnosis, this may explain why she was able to engage in RJA with preferred videos and not with human faces.

According to Dube et al. (2004), social contingencies are less reinforcing for children with ASD. This may also be a factor in why there are differences in processing real and cartoon faces for children with ASD. In the natural environment, JA is reinforced with socially mediated consequences. Therefore, in children with ASD, we can expect lower rates of JA. The current RJA trainings provided additional non-social, preferred items such as access to a fun object on the screen and an edible to counteract the lack of reinforcement from social consequences. These may not have been strong enough reinforcers to increase RJA behaviors to the desired frequency and consistency.

The opposite RJA training with Carl demonstrated only a slight increase in the three training sessions. Carl's increase in RJA was similar to Alexa's increase in RJA in Training 2—shortened. Attending may have been the defining difference between Training 1 influencing Carl's opposite RJA and not having an effect on Alexa's RJA. Carl consistently attended to the videos. However, had he received Training 2—shortened, there may have been a larger increase in the opposite RJA. It is also possible that using pre-recorded videos on an eye tracking device only results in a small increase in JA (20-30%) and not an increase to consistent, typical, levels of responding. From the baseline testing with peers, typical JA with videos is between 50-100%, higher than Carl's engagement in opposite RJA. Since training Carl in opposite RJA was unsuccessful, we can conclude that the training paradigm, as it was, is ineffective.

This was an exploratory study, and as the study progressed necessary changes were made. Because of this, we sacrificed a level of experimental control and created issues with internal validity. With the information gleamed from this study, however, a more systematic version of this study can be replicated using just the Training 2—shortened intervention.

This study also had concerns with experimental control because there was only one participant. Extraneous variables, including exposure to the videos, may have been the cause of the increase in RJA rather than the training. Another concern to validity is the lack of, or low rates, of IOA. The data recorded might not be as precise or accurate as desired. Additional training to prevent observer drift, to clarify definitions, and to increase the IOA should have been implemented. Additionally, procedural integrity of this study is unknown. A fidelity checklist to ensure procedural integrity would be beneficial in attributing the change in behavior to the intervention.

More research, including using a similar training protocol with the changes discussed throughout, should be conducted to determine the effectiveness of using an eye-tracking device and pre-recorded videos to teach JA. Future research should refine the training paradigm to start with fun videos, include socially relevant stimuli, and keep the sessions short. The reinforcers used should be stronger, more salient, and may need to occur after each step in the behavior chain initially. Another possibility is to use live videos. This may help keep the participant interested and may allow for more generalization since it could be more natural. The current training protocol only increased engagement in RJA to 30%. If the training protocol can be refined to create a larger increase in RJA, this can potentially provide a more accessible and easier intervention to teach JA than in-person methodologies.

References

Allison, C., Baron-Cohen, S., Wheelwright, S., Charman, T., Richler, J., Pasco, G., & Brayne, C. (2008). Quantitative Checklist for Autism in Toddlers [Database record]. Retrieved from PsycTESTS. https://doi.org/10.1037/t00433-000

American Psychiatric Association. (2013). Diagnostic and statistical manual of mental disorders (5th ed.). Arlington, VA: American Psychiatric Publishing. https://doi.org/10.1176/appi.books.9780890425596.744053

Baker, M. J. (2000). Incorporating the thematic ritualistic behaviors of children with autism into games: Increasing social play interactions with siblings. *Journal of Positive Behavior Interventions*, *2*(2), 66-84. https://doi.org/10.1177/109830070000200201

Baron-Cohen, S., Allen, J., & Gillberg, C. (1992). Can autism be detected at 18 months? The needle, the haystack, and the CHAT. *The British Journal of Psychiatry*, *161*(6), 839-843. https://doi.org/10.1192/bjp.161.6.839

Benson, R. L., & Joosten, A. V. (2014). Abridged Version of the Early Social Communication Scale--Adapted [Database record]. Retrieved from PsycTESTS. https://doi.org/10.1037/t54986-000

Billeci, L., Narzisi, A., Campatelli, G., Crifaci, G., Calderoni, S., Gagliano, A., ... & Raso, R. (2016). Disentangling the initiation from the response in joint attention: an eye-tracking study in toddlers with autism spectrum disorders. *Translational Psychiatry*, *6*(5), e808. https://doi.org/10.1038/tp.2016.75

Brooks, R., & Meltzoff, A. N. (2005). The development of gaze following and its relation to language. *Developmental Science, 8*(6), 535-543. https://doi.org/10.1111/j.1467-7687.2005.00445.x

Bruinsma, Y., Koegel, R. L., & Koegel, L. K. (2004). Joint attention and children with autism: A review of the literature. *Developmental Disabilities Research Reviews*, *10*(3), 169-175. https://doi.org/10.1002/mrdd.20036

Caruana, N., McArthur, G., Woolgar, A., & Brock, J. (2017). Detecting communicative intent in a computerised test of joint attention. *PeerJ*, *5*, e2899. https://doi.org/10.7717/peerj.2899

Centers for Disease Control and Prevention. (2017). Autism Spectrum Disorders. Retrieved from https://www.cdc.gov/ncbddd/autism/index.html

Charman, T. (2003). Why is joint attention a pivotal skill in autism?. *Philosophical Transactions of the Royal Society B: Biological Sciences*, *358*(1430), 315-324. https://doi.org/10.1098/rstb.2002.1199

Cheng, Y., & Huang, R. (2012). Using virtual reality environment to improve joint attention associated with pervasive developmental disorder. *Research in Developmental Disabilities, 33*(6), 2141-2152. https://doi.org/10.1016/j.ridd.2012.05.023

Constantino, J. N., Kennon-McGill, S., Weichselbaum, C., Marrus, N., Haider, A., Glowinski, A. L., ... & Jones, W. (2017). Infant viewing of social scenes is under genetic control and is atypical in autism. *Nature*, *547*(7663), 340. https://doi.org/10.1038/nature22999

Cooper, J. O., Heron, T. E., & Heward, W. L. (2007). *Applied Behavior analysis*. Upper Saddle River, NJ: Prentice Hall.

D'Entremont, B., Hains, S. M. J., & Muir, D. W. (1997). A demonstration of gaze following in 3-to 6-month-olds. *Infant Behavior and Development*, *20*(4), 569-572. https://doi.org/10.1016/S0163-6383(97)90048-5

Dube, W. V., MacDonald, R. P., Mansfield, R. C., Holcomb, W. L., & Ahearn, W. H. (2004). Toward a behavioral analysis of joint attention. *The Behavior Analyst*, *27*(2), 197-207. https://doi.org/10.1007/BF03393180

Eyberg, S. (1988). Parent-child interaction therapy: Integration of traditional and behavioral concerns. *Child & Family Behavior Therapy*, *10*(1), 33-46. https://doi.org/10.1300/J019v10n01_04

Falck-Ytter, T., Bölte, S., & Gredebäck, G. (2013). Eye tracking in early autism research. *Journal of Neurodevelopmental Disorders, 5*(1), 28. https://doi.org/10.1186/1866-1955-5-28

Grelotti, D. J., Klin, A. J., Gauthier, I., Skudlarski, P., Cohen, D. J., Gore, J. C., ... & Schultz, R. T. (2005). fMRI activation of the fusiform gyrus and amygdala to cartoon characters but not to faces in a boy with autism. *Neuropsychologia*, *43*(3), 373-385. https://doi.org/10.1016/j.neuropsychologia.2004.06.015

Henderson, J. M., & Hollingworth, A. (1998). Eye movements during scene viewing: An overview. *Eye Guidance in Reading and Scene Perception* (pp. 269-293). https://doi.org/10.1016/B978-008043361-5/50013-4

Johnson, S. P., Amso, D., & Slemmer, J. A. (2003). Development of object concepts in infancy: Evidence for early learning in an eye-tracking paradigm. *Proceedings of* *the National Academy of Sciences*, *100*(18), 10568-10573. https://doi.org/10.1073/pnas.1630655100

Johnston, J. M., & Pennypacker, H. S. (2009). *Strategies and Tactics of Behavioral Research* (3rd ed.). New York, NY: Routledge. https://doi.org/10.4324/9780203837900

Kasari, C., Freeman, S., & Paparella, T. (2006). Joint attention and symbolic play in young children with autism: A randomized controlled intervention study. *Journal of Child Psychology and Psychiatry*, *47*(6), 611-620. https://doi.org/10.1111/j.1469-7610.2005.01567.x

Kasari, C., Sigman, M., Mundy, P., & Yirmiya, N. (1990). Affective sharing in the context of joint attention interactions of normal, autistic, and mentally retarded children. *Journal of Autism and Developmental Disorders*, *20*(1), 87-100. https://doi.org/10.1007/BF02206859

Koegel, L. K., Koegel, R. L., Harrower, J. K., & Carter, C. M. (1999). Pivotal response intervention I: Overview of approach. *Journal of the Association for Persons with Severe Handicaps*, *24*(3), 174-185. https://doi.org/10.2511/rpsd.24.3.174

Koegel, R. L., Koegel, L. K., & Carter, C. M. (1999). Pinotal teaching interactions for children with Autism. *School Psychology Review*, *28*(4), 576.

Koegel, R. L., Russo, D. C., & Rincover, A. (1977). Assessing and Training Teachers in the Generalized Use of Behavior Modification with Autistic Children. *Journal of Applied Behavior Analysis*, *10*(2), 197-205. https://doi.org/10.1901/jaba.1977.10-197

Lauricella, A. R., Barr, R., & Calvert, S. L. (2016). Toddler learning from video: Effect of matched pedagogical cues. *Infant Behavior and Development*, *45*, 22-30. https://doi.org/10.1016/j.infbeh.2016.08.001

Lobo, M. A., Moeyaert, M., Cunha, A. B., & Babik, I. (2017). Single-case design, analysis, and quality assessment for intervention research. *Journal of Neurologic Physical Therapy: JNPT*, *41*(3), 187. https://doi.org/10.1097/NPT.0000000000000187

Loveland, K. A., & Landry, S. H. (1986). Joint attention and language in autism and developmental language delay. *Journal of Autism and Developmental Disorders*, *16*(3), 335-349. https://doi.org/10.1007/BF01531663

McClure, E. R., Chentsova-Dutton, Y. E., Holochwost, S. J., Parrott, W. G., & Barr, R. (2018). Look at that! Video chat and joint visual attention development among babies and toddlers. *Child Development*, *89*(1), 27-36. https://doi.org/10.1111/cdev.12833

McEachin, J. J., Smith, T., & Ivar Lovaas, O. (1993). Long-term outcome for children with autism who received early intensive behavioral treatment. *American Journal of Mental Retardation*, *97*, 359-359.

Moser, A., Zimmermann, L., Dickerson, K., Grenell, A., Barr, R., & Gerhardstein, P. (2015). They can interact, but can they learn? Toddlers' transfer learning from touchscreens and television. *Journal of Experimental Child Psychology*, *137*, 137-155. https://doi.org/10.1016/j.jecp.2015.04.002

Mundy, P., & Crowson, M. (1997). Joint attention and early social communication: Implications for research on intervention with autism. *Journal of Autism and*

Developmental disorders, *27*(6), 653-676. https://doi.org/10.1023/A:1025802832021

Mundy, P., Sigman, M., & Kasari, C. (1990). A longitudinal study of joint attention and language development in autistic children. *Journal of Autism and Developmental Disorders*, *20*(1), 115-128. https://doi.org/10.1007/BF02206861

Naoi, N., Tsuchiya, R., Yamamoto, J. I., & Nakamura, K. (2008). Functional training for initiating joint attention in children with autism. *Research in Developmental Disabilities*, *29*(6), 595-609. https://doi.org/10.1016/j.ridd.2007.10.001

Navab, A., Gillespie-Lynch, K., Johnson, S. P., Sigman, M., & Hutman, T. (2012). Eye-Tracking as a measure of responsiveness to joint attention in infants at risk for autism. *Infancy*, *17*(4), 416-431. https://doi.org/10.1111/j.1532-7078.2011.00082.x

Oakes, L. M. (2012). Advances in eye tracking in infancy research. *Infancy*, *17*(1), 1-8. https://doi.org/10.1111/j.1532-7078.2011.00101.x

Oberwelland, E., Schilbach, L., Barisic, I., Krall, S. C., Vogeley, K., Fink, G. R., ... & Schulte-Rüther, M. (2016). Look into my eyes: Investigating joint attention using interactive eye-tracking and fMRI in a developmental sample. *NeuroImage*, *130*, 248-260. https://doi.org/10.1016/j.neuroimage.2016.02.026

Parsonson, B. S. (2003). Visual analysis of graphs: Seeing is believing. *A Small Matter of Proof: The Legacy of Donald M. Baer*, 35-51.

Pelios, L. V., & Lund, S. K. (2001). A selective overview of issues on classification, causation, and early intensive behavioral intervention for autism. *Behavior Modification*, *25*(5), 678-697. https://doi.org/10.1177/0145445501255002

Smith, T. (2001). Discrete trial training in the treatment of autism. *Focus on Autism and Other Developmental Disabilities*, *16*(2), 86-92. https://doi.org/10.1177/108835760101600204

Stokes, T. F., & Baer, D. M. (1977). An implicit technology of generalization 1. *Journal of Applied Behavior Analysis*, *10*(2), 349-367. https://doi.org/10.1901/jaba.1977.10-349

Rocha, M. L., Schreibman, L., & Stahmer, A. C. (2007). Effectiveness of training parents to teach joint attention in children with autism. *Journal of Early Intervention*, *29*(2), 154-172. https://doi.org/10.1177/105381510702900207

Rosales-Ruiz, J., & Baer, D. M. (1997). Behavioral cusps: A developmental and pragmatic concept for behavior analysis. *Journal of Applied Behavior Analysis*, *30*(3), 533-544. https://doi.org/10.1901/jaba.1997.30-533

Rosset, D. B., Santos, A., Da Fonseca, D., Poinso, F., O'Connor, K., & Deruelle, C. (2010). Do children perceive features of real and cartoon faces in the same way? Evidence from typical development and autism. *Journal of Clinical and Experimental Neuropsychology*, *32*(2), 212-218. https://doi.org/10.1080/13803390902971123

Rozga, A., Hutman, T., Young, G. S., Rogers, S. J., Ozonoff, S., Dapretto, M., & Sigman, M. (2011). Behavioral profiles of affected and unaffected siblings of children with autism: Contribution of measures of mother–infant interaction and nonverbal communication. *Journal of Autism and Developmental Disorders*, *41*(3), 287-301. https://doi.org/10.1007/s10803-010-1051-6

Taylor, B. A., & Hoch, H. (2008). Teaching children with autism to respond to and initiate bids for joint attention. *Journal of Applied Behavior Analysis*, *41*(3), 377-391. https://doi.org/10.1901/jaba.2008.41-377

Thorup, E., Nyström, P., Gredebäck, G., Bölte, S., & Falck-Ytter, T. (2016). Altered gaze following during live interaction in infants at risk for autism: an eye tracking study. *Molecular Autism*, 7(1), 12. https://doi.org/10.1186/s13229-016-0069-9

Toth, K., Munson, J., Meltzoff, A. N., & Dawson, G. (2006). Early predictors of communication development in young children with autism spectrum disorder: Joint attention, imitation, and toy play. *Journal of Autism and Developmental Disorders*, *36*(8), 993-1005. https://doi.org/10.1007/s10803-006-0137-7

Vismara, L. A., & Lyons, G. L. (2007). Using perseverative interests to elicit joint attention behaviors in young children with autism: Theoretical and clinical implications for understanding motivation. *Journal of Positive Behavior Interventions*, *9*(4), 214-228. https://doi.org/10.1177/10983007070090040401

Vollmer, T. R., & Iwata, B. A. (1991). Establishing operations and reinforcement effects. *Journal of Applied Behavior Analysis*, *24*(2), 279-291. https://doi.org/10.1901/jaba.1991.24-279

Wang, Q., Celebi, F. M., Flink, L., Greco, G., Wall, C., Prince, E., ... & DiNicola, L. (2015, June). Interactive eye tracking for gaze strategy modification. *In Proceedings of the 14th International Conference on Interaction Design and Children* (pp. 247-250). ACM. https://doi.org/10.1145/2771839.2771888

Wass, S., Porayska-Pomsta, K., & Johnson, M. H. (2011). Training attentional control in infancy. *Current Biology*, *21*(18), 1543-1547. https://doi.org/10.1016/j.cub.2011.08.004

Whalen, C., & Schreibman, L. (2003). Joint attention training for children with autism using behavior modification procedures. *Journal of Child Psychology and Psychiatry*, *44*(3), 456-468. https://doi.org/10.1111/1469-7610.00135

Whalen, C., Schreibman, L., & Ingersoll, B. (2006). The collateral effects of joint attention training on social initiations, positive affect, imitation, and spontaneous speech for young children with autism. *Journal of Autism and Developmental Disorders*, *36*(5), 655-664. https://doi.org/10.1007/s10803-006-0108-z

White, P. J., O'Reilly, M., Streusand, W., Levine, A., Sigafoos, J., Lancioni, G., ... & Aguilar, J. (2011). Best practices for teaching joint attention: A systematic review of the intervention literature. *Research in Autism Spectrum Disorders*, *5*(4), 1283-1295. https://doi.org/10.1016/j.rasd.2011.02.003

Figures

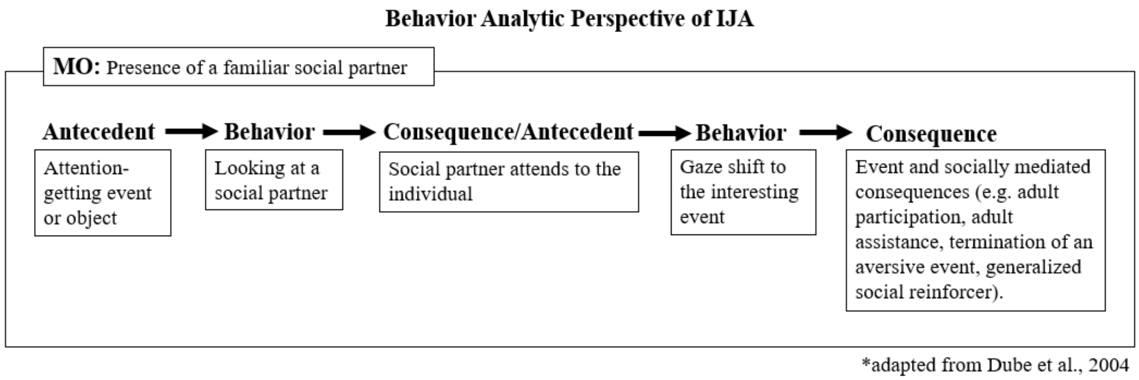


Figure 1: A contingency diagram, adapted from Dube et al. (2004) of the behavior analytic perspective of IJA

Behavior Analytic Perspective of RJA

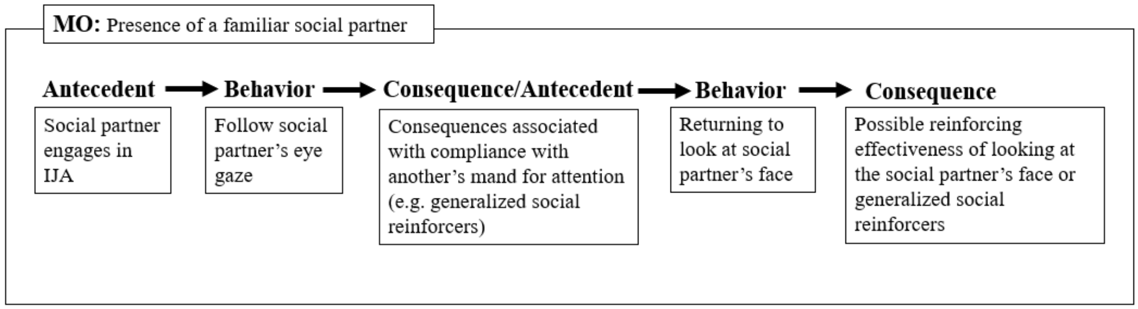


Figure 2: A contingency diagram of the behavior analytic perspective of RJA.

Prompt Sequence Training 1

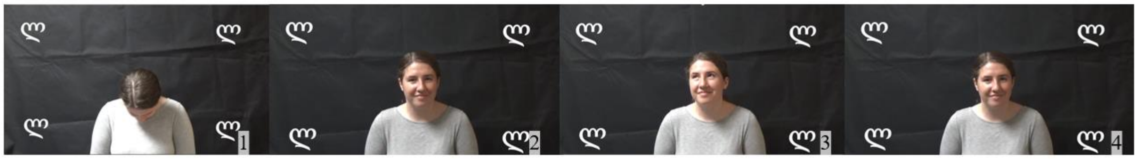


Figure 3: An example of the Training 1 videos. The videos consisted of the model looking down, then at the screen for 10 seconds, then to one of the four unfamiliar objects for 10 seconds, and then back to the screen for 10 seconds.

Prompt Sequence Training 2

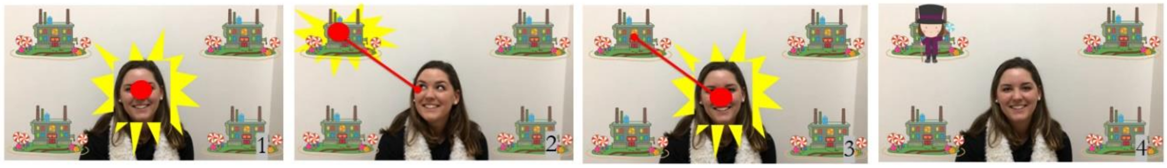


Figure 4: An example of the Training 2 videos. The videos consisted of flashing around the model's face (picture 1), flashing around the object the model looked toward (picture 2), and flashing around the models face again (picture 3) to demonstrate JA. Picture 4 shows an example of the fun character that appeared after the participant engaged in JA in Training 2. The red dots and lines indicate where someone with RJA would look and demonstrate how RJA is observed on the eye tracking device. The participant could not see the red dots/lines.

Prompt Fading

Figure 5: An example of the different level of prompts and faded backgrounds in the Training 2 videos. The left-most picture, prompt A shows no background, prompt B shows 60% faded background, prompt C shows 30% faded background, and prompt D shows no fading. Each of these show the starburst that flashed behind the model's face and then the object.

Decision Tree

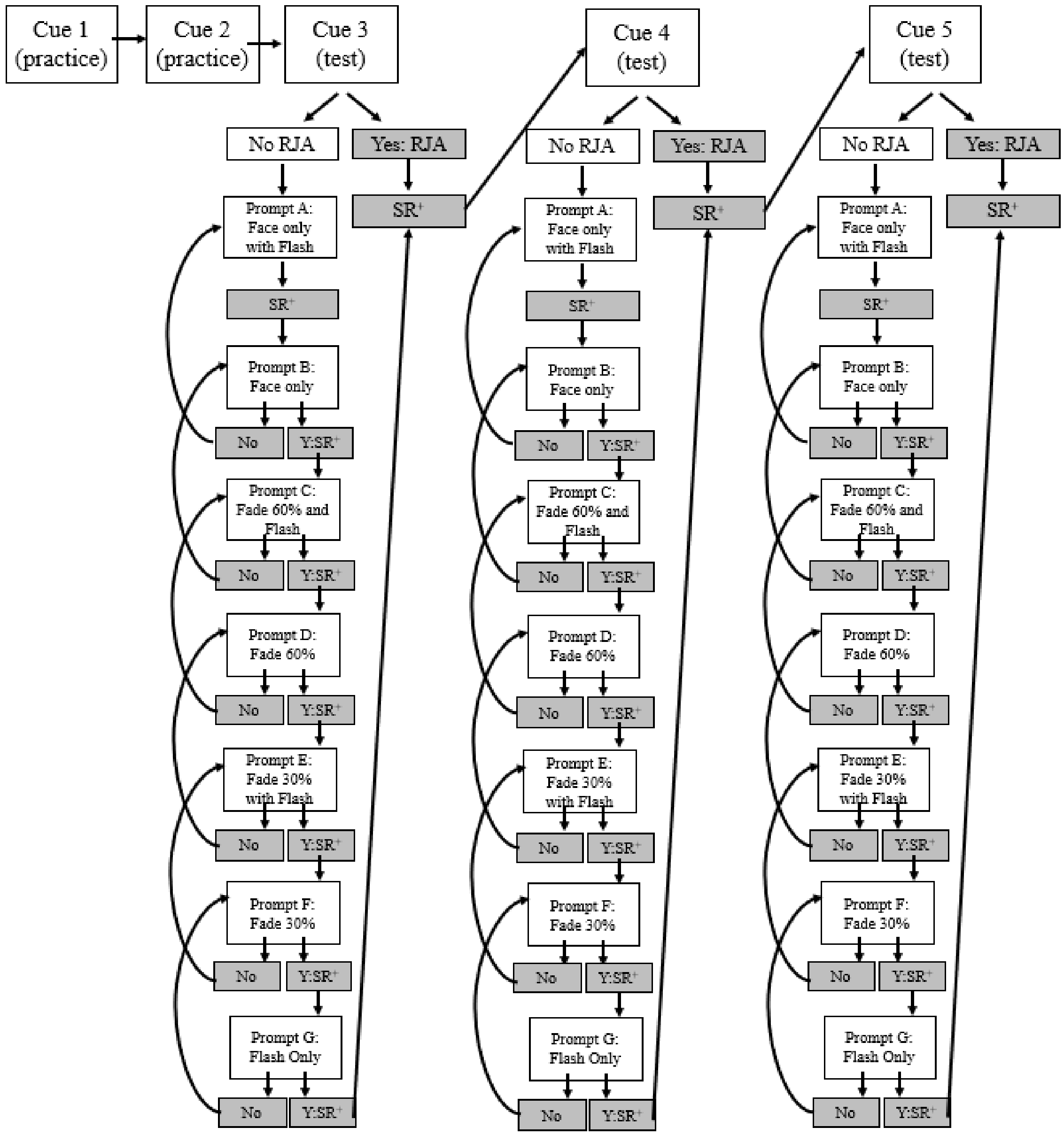


Figure 6: Diagram of Decision Tree for Training 1. The decision tree for Training 2 and Training 2—shortened is the same, except it only contains the videos with the flashing (prompt A, C, E, and G). The sequence started at cue 1.

Pre-Baseline Timeline

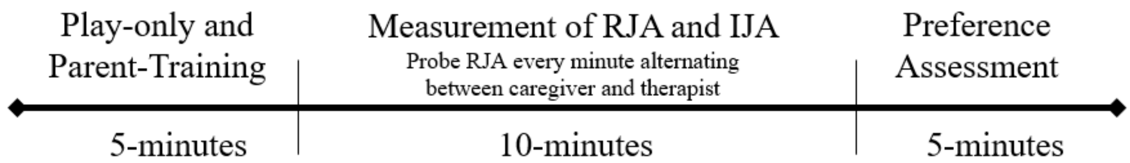


Figure 7: Timeline of Pre-Baseline Session

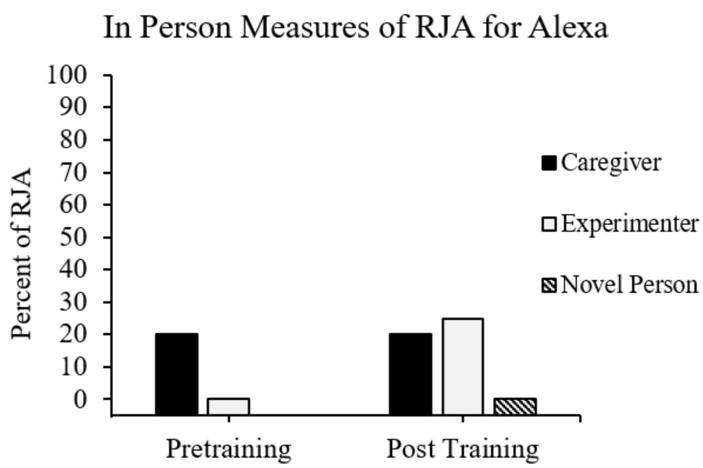


Figure 8: Graph of the Pre-Training and Post-Training Levels of Alexa’s engagement in RJA during the in-person sessions with her caregiver, the experimenter, and a novel person. A novel person was not tested in pretraining because the experimenter was novel.

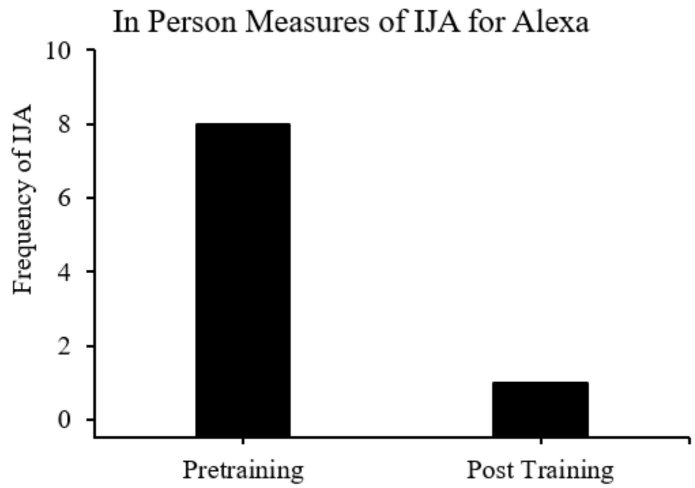


Figure 9: Graph of the Pre-Training and Post-Training Levels of Alexa's IJA during ten-minutes of the in-person sessions.

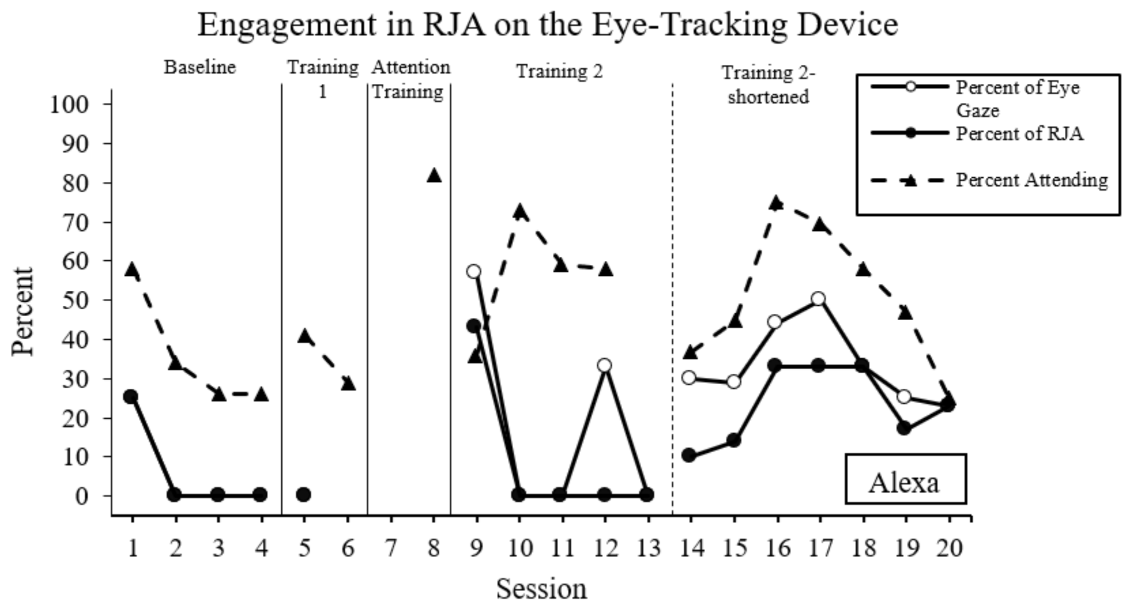


Figure 10: Graph of Alexa's engagement in RJA and eye gaze, as well as the percentage she attended to the videos on the eye-tracking device.

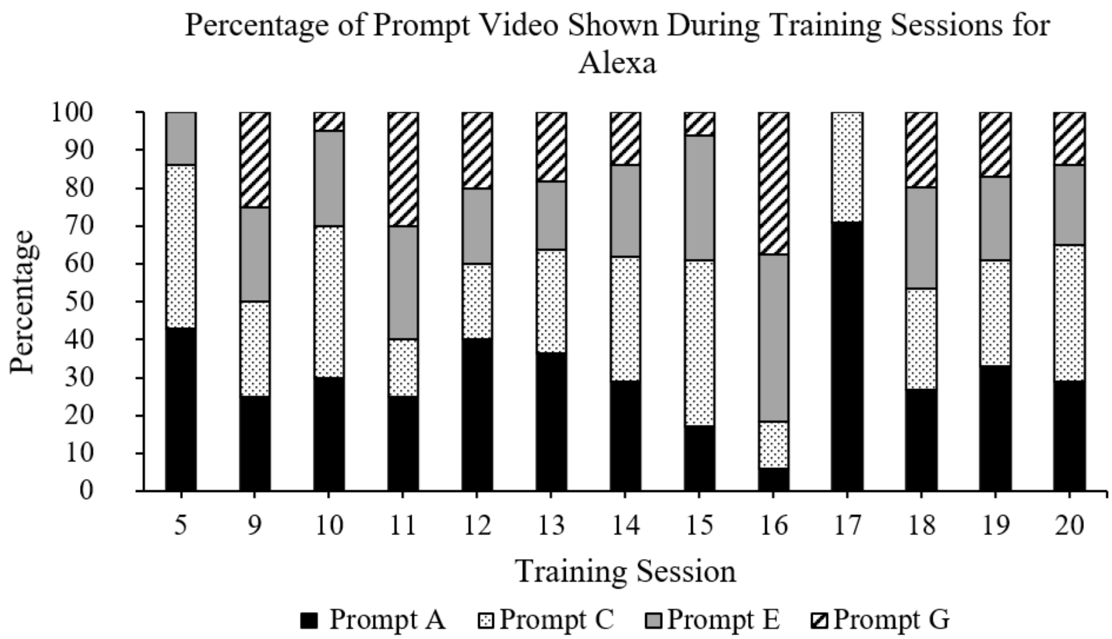


Figure 11: This graph displays what prompt videos were shown during the Training 2 conditions for Alexa.

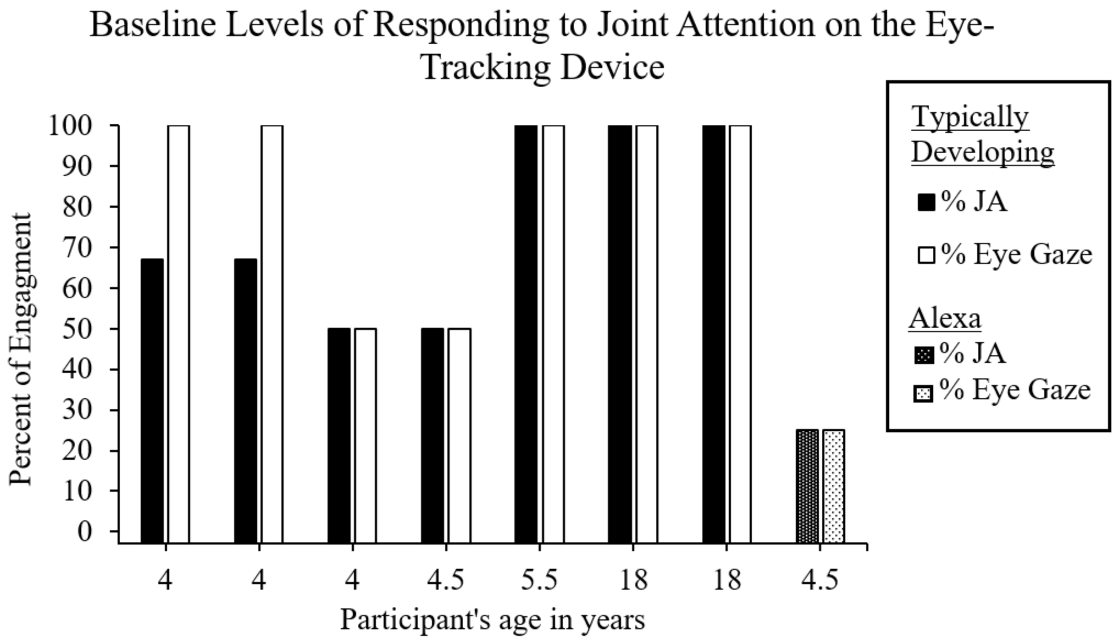


Figure 12: This graph shows the percent engagement in RJA from cue videos in both typically developing children and adults, as well as Alexa. Alexa’s bars have the dotted patterns. Additionally, Carl is included in this graph as the participant who is 5.5 years of age.

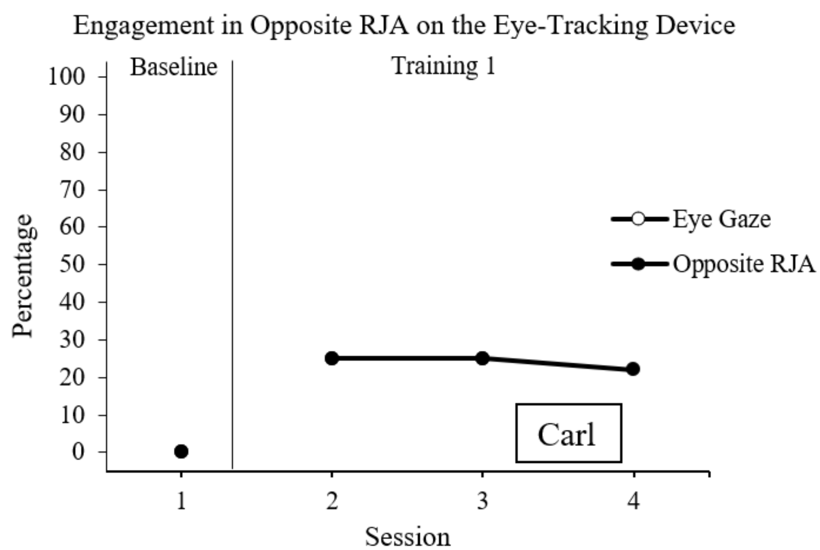


Figure 13: This graph shows Carl's engagement in Opposite RJA in baseline and intervention (Training 1). The percentage of eye gaze equaled the percentage of opposite RJA for each session.

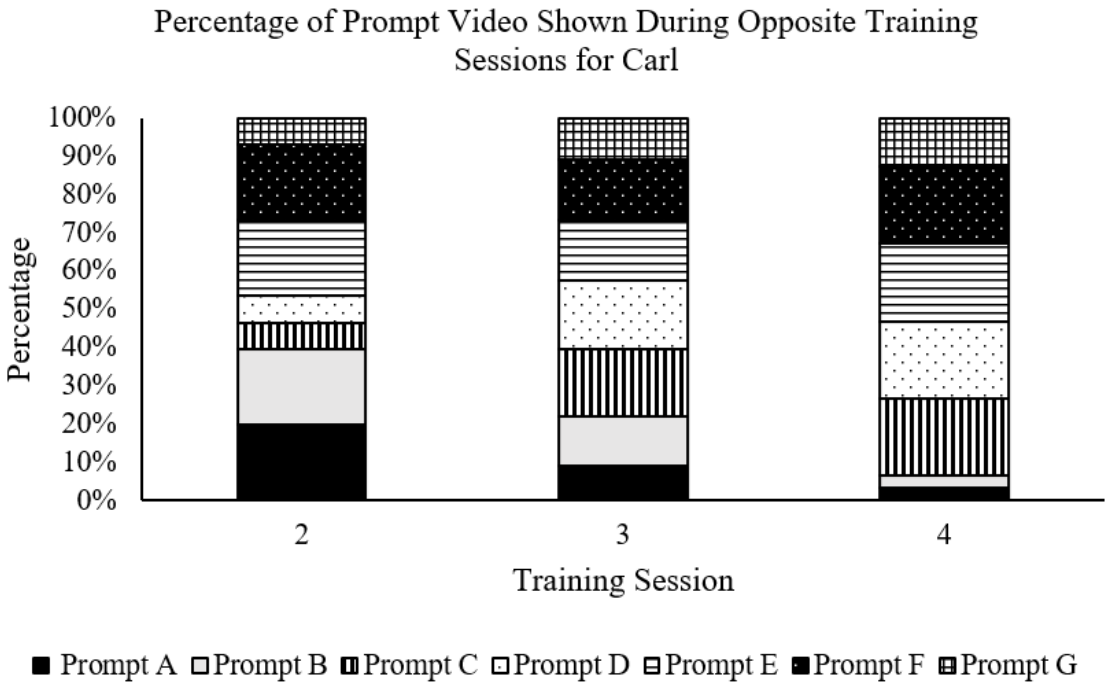


Figure 14: This graph depicts which prompt videos were shown in the Training 1 condition of opposite RJA training for Carl.

Appendix

Appendix A: Screening Questions for the Primary Caregiver

Screening Questions for the Primary Caregiver:

1. Does your child look at you when you call his/her name?
    a. Always
    b. Usually
    c. Sometimes
    d. Rarely
    e. Never
2. How easy is it for you to get eye-contact with your child?
    a. Very easy
    b. Quite easy
    c. Quite difficult
    d. Very difficult
    e. Impossible
3. Does your child point to indicate that she/he wants something (e.g. a toy that is out of reach)?
    a. Many times a day
    b. A few times a day
    c. A few times a week
    d. Less than once a week
    e. Never
4. Does your child point to share interest with you (e.g. pointing at an interesting sight)?
    a. Many times a day
    b. A few times a day
    c. A few times a week
    d. Less than once a week
    e. Never
5. Does your child follow where you're looking?
    a. Many times a day
    b. A few times a day
    c. A few times a week
    d. Less than once a week
    e. Never
6. Does your child immediately turn their head or direct their eyes toward an object/toy/picture that you are pointing at? This can include a verbal prompt.
    a. Always
    b. Usually
    c. Sometimes
    d. Rarely
    e. Never
7. Does your child look directly at the face of the social partner in response to the social partner's attempt to gain eye contact?

   a. Always
   b. Usually
   c. Sometimes
   d. Rarely
   e. Never
8. Does your child look at the face of a social partner, then directly at the object/toy?
   a. Always
   b. Usually
   c. Sometimes
   d. Rarely
   e. Never
9. Does your child look directly at the face of the social partner in order to make eye contact, while touching/manipulating/holding an inactive object/toy?
   a. Always
   b. Usually
   c. Sometimes
   d. Rarely
   e. Never
10. Does your child point to an active object/toy with the index finger extended and the other fingers noticeably flexed in a downward position?
    a. Always
    b. Usually
    c. Sometimes
    d. Rarely
    e. Never
11. Does your child raise an object/toy to the social partner’s face in order to make eye contact and hold it still for a second or two?
    a. Always
    b. Usually
    c. Sometimes
    d. Rarely
    e. Never
12. How many hours per day does your child spend on video chat (e.g. facetime, skype)
    a. 0-.5 hours
    b. .5-1 hour
    c. 1-2 hour
    d. 2-4 hour
    e. 4 or more hours
13. How many hours per day does your child watch television?
    a. 0-.5 hours
    b. .5-1 hour
    c. 1-2 hour
    d. 2-4 hour
    e. 4 or more hours

14. Do any of the child's older siblings have ASD or another disability?
    a. Yes (if other disability, list: _________________)
    b. No
15. Are there any medical concerns, specifically regarding vision?
    a. Yes (list:____)
    b. No

Preference Assessment

	Least Preferred		**Somewhat**		**Most Preferred**
	1	**2**	**3**	**4**	**5**
Bubbles					
Food (type:_______)					
Food (type:_______)					
Food (type:_______)					
Tickles/touch					
Stuffed animals					
Dolls					
Music					
Toy Trains					
Toy Cars					

Appendix B: Demographic Survey

Please answer the following questions about your child.

Birthdate: ________________

Diagnosis (if any):
____

How many years has your child been in school (including preschool)?
____

Gender: Male Female Other

Race/Ethnicity: White Black Hispanic Asian Other
Circle all that apply

Appendix C: Data Sheets

In-Person Data Sheet

Date: Participant ID: Observer ID:

In Person Session

1) Play-only and parent-training

2) Parent Practice IJA (do not take data on child behavior)

    a. Coach prompts the experimenter to demonstrate IJA, and then the caregiver to practice IJA.

3) Measurement of RJA with a FAMILIAR Person

    Responding to Joint Attention (RJA) is when the child directs their attention to the location cued by eye-gaze and a slight head turn of the social partner. The child must fixate for at least one second on the item/event and then return their attention to the social partner within 10 seconds of the social partner's cue. Attention will be measured as looking; the child's eyes must be looking at the location. Prior to the social partner initiating in JA, the child must be attending to the social partner for RJA to be scored. The social partner can call the child's name or get their attention through other means.

TIME OF FIRST RJA:

+	Yes; engaged in RJA
-	No; did not engage in RJA
NA	Child was Not Attending to the Adult
NO	JA was Not Observed (observer was unable to see whether JA occurred or not)

<u>Frequency of Spontaneous IJA:</u>

Minute	**Person**	**Joint Attention** +, -, NA, NO	**Eye Gaze** +, -
1	Experimenter		
2	Caregiver		
3	Experimenter		
4	Caregiver		
5	Experimenter		
6	Caregiver		
7	Experimenter		
8	Caregiver		
9	Experimenter		
10	Caregiver		

Eye-Tracking Baseline Data Sheet

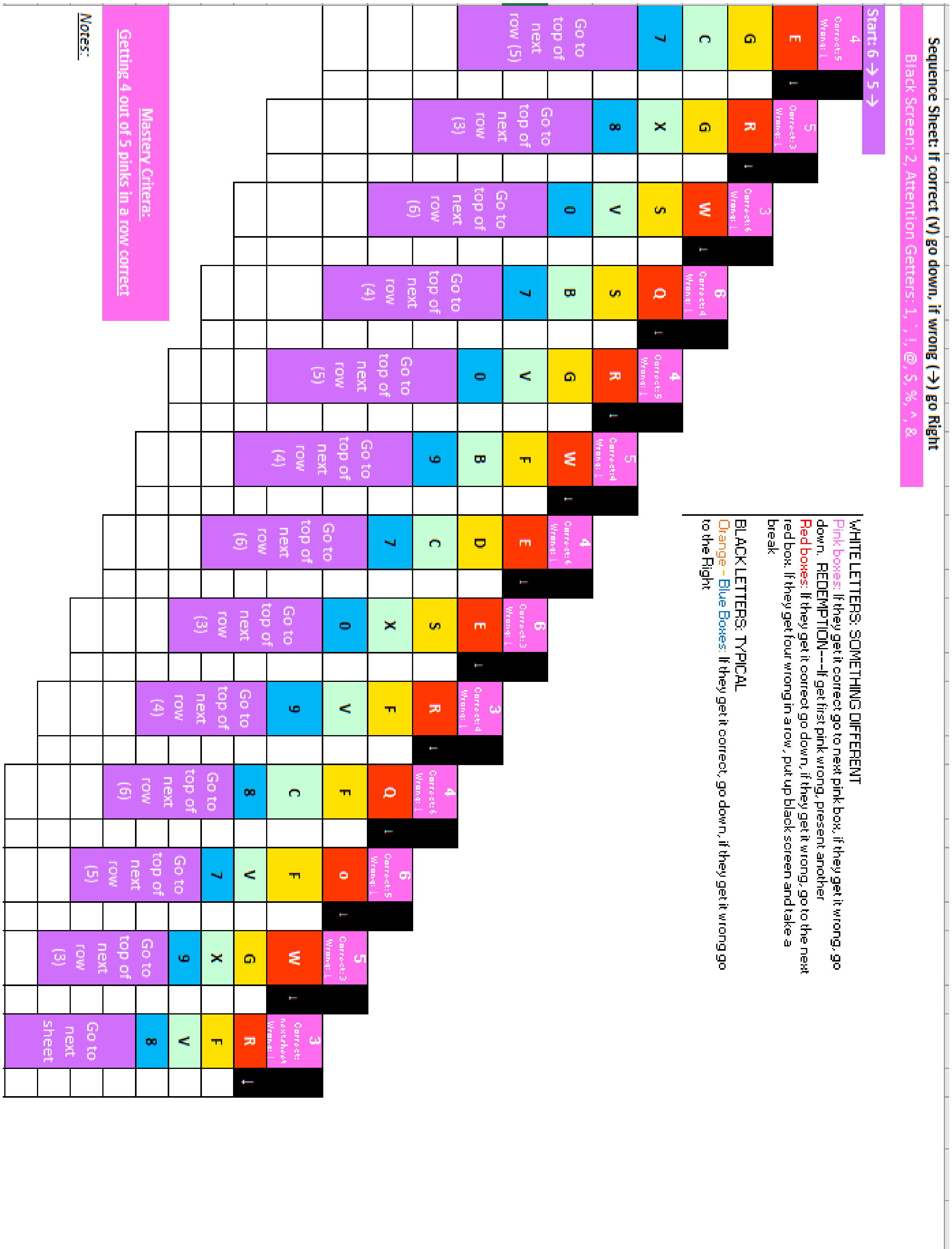
Date: _______ Participant ID:_______

Video	JA? (+ for yes, - for no)
6	
4	
3	
5	
6	

Break

Video	JA? (+ for yes, - for no)
3	
6	
4	
5	
4	

Eye-Tracking Sequence Data Sheet



Eye-Tracking Data Sheet

Date: _________________ Observer ID: ____________

Participant ID: __________

Video Type	**Key Pressed**	**JA (+) or No JA (-)**	**Notes**

Attention Training Data Sheet

Date:___________ Participant ID:___________ Observer ID:______________

Shaping Procedure

Black Screen: 1, Attention Getters: 2, 3, 4, 5, 6	
Fun Videos: 7, 8, 9, 0, !, @, $, %, ^, &, *, (,)	

[redacted]

Attend for 3 consecutive seconds

Video	Attended?
q	
d	
v	
[	
n	

Attend for 6 consecuitve seconds

Video	Attended?
h	
o	
b	
f	
y	

Attend for 9 consecuitve seconds

Video	Attended?
c	
g	
i	
f	
s	